Chapter A9: Economic Benefit Categories and Valuation Methods

INTRODUCTION

CHAPTER CONTENTS

Valuing the changes in environmental quality that arise from the § 316(b) regulations for existing facilities is a principal desired outcome for the Agency's policy assessment framework. Changes in Cooling Water Intake Structure (CWIS) design or operations reduce impingement and entrainment (I&E) rates. These changes in I&E can potentially yield significant ecosystem improvements in terms of the number of fish and other aquatic organisms that avoid premature mortality. This in turn is expected to increase the numbers of individuals present, increase local and regional fishery populations, and ultimately contribute to the enhanced environmental functioning of affected waterbodies (rivers, lakes, estuaries, and oceans) and associated ecosystems. The economic welfare of human populations is expected to increase as a consequence of the improvements in fisheries and associated aquatic ecosystem functioning.

Below, we identify the types of economic benefits that are likely to be generated from the proposed existing facilities rulemaking's anticipated reductions in adverse effects of CWIS. We explain the basic economic concepts applicable to the economic benefits, including benefit categories and taxonomies associated with market and nonmarket goods and services that are likely to flow from reduced I&E. Also described are the methods and data sources used to develop empirical estimates of the benefits of proposed regulatory actions. These methods are applied to the case studies reported in Parts B through I of this document.

A9-1 ECONOMIC BENEFIT CATEGORIES APPLICABLE TO THE § 316(B) RULE

To estimate the economic benefits of reducing I&E at existing CWIS, all the beneficial outcomes need to be identified and, where possible, quantified and assigned appropriate monetary values. Estimating economic benefits can be challenging because many steps need to be analyzed to link a reduction in I&E to changes in impacted fisheries and other aspects of relevant aquatic ecosystems, and to then link these ecosystem changes to the resulting changes in quantities and values for the associated environmental goods and services that ultimately are linked to human welfare.

Key challenges in benefits assessment include uncertainties and data gaps, as well as the fact that many of the goods and services beneficially affected by the proposed change in existing facility I&E are not traded in the marketplace. Thus there are numerous instances — including this proposed § 316(b) rule for existing facilities — when it is not feasible to confidently assign monetary values based on observed market transactions (e.g., prices) for some of the important beneficial outcomes. In such instances, several types of benefits need to be estimated using nonmarket valuation techniques. Where this cannot be done in a reliable manner, the benefits need to be described and considered qualitatively.

For the proposed existing facilities rule, the benefits are likely to consist of several categories (as discussed below), some of which are linked to direct use of market goods and services, and several of which pertain to nonmarket goods and services. Accordingly, some are quantified and valued using secondary nonmarket valuation data (e.g., benefits transfer), and some benefits are described only qualitatively. In addition, some nonmarket benefits are estimated using primary research methods. In specific, recreational values are estimated for some of the case studies (those that are examined on a watershed-scale) using a Random Utility Model (RUM), which is described in Chapter A10. Also, some benefits estimates are developed using habitat-based restoration costing (HRC) as an innovative alternative to using replacement costs as a proxy for beneficial values (see Chapter A11).

In addition to the methodological complexities of estimating benefits, many of the factors that contribute to generating benefits are highly site-specific. For example, the extent of recreational or commercial fishing benefits will depend on baseline levels of I&E for a facility, which fish species are present, how the I&E impacts for those species are reduced by regulatory options (relative to baseline), and the size, preferences, and socio-economic characteristics of human populations in proximity to the affected aquatic systems (i.e., those individuals likely to have a demand for an improved fishery in the affected waters). Thus, the benefits assessment is based on a series of facility- and site-specific case studies that are intended to provide representative and plausible estimates of the benefits of the rulemaking.

A9-2 BENEFIT CATEGORY TAXONOMIES

The term "economic benefits" here refers to the dollar value associated with all the expected positive impacts of the § 316(b) regulation being proposed for existing facilities. Conceptually, the monetary value of benefits is the sum of the predicted changes in "consumer and producer surplus." These surplus measures are standard and widely accepted terms of applied welfare economics, and reflect the degree of well-being derived by economic agents (e.g., people or firms) given different levels of goods and services, including those associated with environmental quality.[1]

The economic benefits of activities that improve environmental conditions can be categorized in many different ways. The various terms and categories offered by different authors can lead to some confusion with semantics. However, the most critical issue is to try not to omit any relevant benefit, and at the same time avoid potential double counting of benefits.

One common classification for benefits of environmental programs is to divide them into three main categories of (1) economic welfare (e.g., changes in the well-being of humans who derive use value from market or nonmarket goods and services such as fisheries); (2) human health (e.g., the value of reducing the risk of premature fatality due to changing exposure to environmental exposure); and (3) nonuse values (e.g., stewardship values for the desire to preserve T&E species). For the § 316(b) regulation, however, this classification does not convey all the intricacies of how the rule might generate benefits. Further, human health benefits are not anticipated. Therefore, another categorization may be more informative.

Figure A9-1: Benefits Categories for § 316(b)

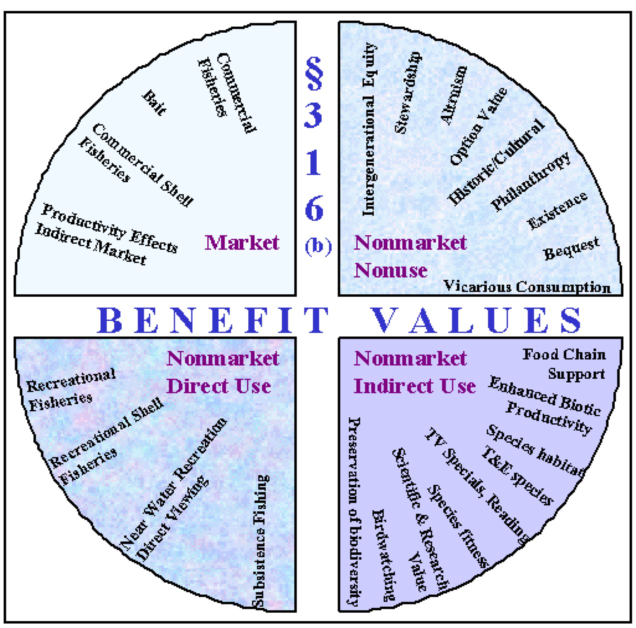

Figure A9-1 outlines the most prominent categories of benefit values for the § 316(b) rule. The four quadrants are divided by two principles: (1) whether the benefit can be tracked in a market (i.e., market goods and services) and (2) how the benefit of a nonmarket good is received by human beneficiaries (either from direct use of the resource, from indirect use, or from nonuse).

Market benefits for § 316(b) are best typified by commercial fisheries, where a change in fishery conditions will manifest itself in the price, quantity, and/or quality of fish harvests. The fishery changes thus result in changes in the marketplace, and can be evaluated based on market exchanges.

Direct use benefits also include the value of improved environmental goods and services used and valued by people (whether or not these services or goods are traded in markets). A typical nonmarket direct use would be recreational angling, in which participants enjoy a welfare gain when the fishery improvement results in a more enjoyable angling experience (e.g., higher catch rates).

[1] Technically, consumer surplus reflects the difference between the "value" an individual places on a good or service (as reflected by the individual's "willingness to pay" for that unit of the good or service) and the "cost" incurred by that individual to acquire it (as reflected by the "price" of a commodity or service, if it is provided in the marketplace). Graphically, this is the area bounded from above by the demand curve and below by the market clearing price. Producer surplus is a similar concept, reflecting the difference between the market price a producer can obtain for a good or service and the actual cost of producing that unit of the commodity.

Indirect use benefits refer to changes that contribute, through an indirect pathway, to an increase in welfare for users (or nonusers) of the resource. An example of an indirect benefit would be when the increase in the number of forage fish enables the population of valued predator species to improve (e.g., when the size and numbers of prized recreational or commercial fish increase because their food source has been improved). In such a context, reducing I&E of forage species will indirectly result in welfare gains for recreational or commercial anglers.

Nonuse benefits — also known as passive use values — reflect the values individuals assign to improved ecological conditions apart from any current, anticipated, or optional use by them. The most commonly cited motives for nonuse values include bequest and existence values. Bequest values reflect the willingness to pay to ensure that applicable environment-related goods and services are available to future generations at a given level of quality and quantity. It reflects concerns over intergenerational equity with respect to leaving a given level of environmental quality as an endowment for those who follow after us in time. Existence value (sometimes referred to as stewardship value) reflects the willingness to pay that humans place on preserving or enhancing ecosystem integrity or a given aspect of environmental quality. This motive applies not only to protecting endangered and threatened species (i.e., avoiding an irreversible impact), but also applies (though perhaps at lesser values) for impacts that potentially are reversible or that affect relatively abundant species and/or habitats.[2]

As noted above, the key to any benefits taxonomy is to try to clearly capture all the types of beneficial outcomes that are expected to arise from a policy action, while at the same time avoiding any possible double counting. Hence, it makes little difference where some of the specific types of benefits are categorized within Figure A9-1. An additional complication with using any single taxonomy for benefits categories is that some valuation approaches may capture more than one benefit category or reflect multiple types of benefits that exist in more than one category or quadrant in the diagram. For example, habitat restoration may enhance populations of recreational, commercial, and forage species alike. Hence if habitat restoration costs are used as a proxy for the value of reduced I&E impacts, the benefits estimates derived embody values for a mix of direct and indirect uses, including both market and nonmarket goods and services. Accordingly, care is used in the case studies to preclude double counting when monetized benefits estimates are compiled, since in some instances monetary estimates from one approach may overlap with values captured by another methodology. All monetized values included in all categories if not given in year 2000 dollars are inflated to year 2000 dollars using an index from Friedman (2002).

A9-3 Direct Use Benefits

Direct use benefits are the simplest to envision. The welfare of commercial, recreational, and subsistence fishermen is improved when fish stocks increase and their catch rates rise. This increase in stocks may be induced by reduced I&E of species sought by fishermen, or through reduced I&E of forage and bait fish, which leads to increases in populations of commercial and recreational species that prey on the forage species. For subsistence fishermen, the increase in fish stocks may reduce the amount of time spent fishing for their meals or increase the number of meals they are able to catch. For recreational anglers, more fish and higher catch rates may increase the enjoyment of a fishing trip and may also increase the number of fishing trips taken. For commercial fishermen, larger fish stocks may lead to

> Allocating Fish to Commercial and Recreational Harvests
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> Many of the I&E-impacted fish species at CWIS sites are harvested both recreationally and commercially. To avoid double-counting the economic impacts of I&E of these species, we determine the proportion of total species landings attributable to recreational and commercial fishing, and apply this proportion to the number of impacted fishery catch. For example, if 30 percent of the landed numbers of one species are harvested commercially at a site, then 30 percent of the estimated catch of I&E-impacted fish are assigned to the increase in commercial landings. The remaining 70 percent of the estimated total landed number of I&E-spared adult equivalents are assigned to the recreational landings.
>
> The National Marine Fisheries Service (NMFS) provides both commercial and recreational fishery landings data by state. To determine what proportion of total landings per state occur in the commercial or recreational fishery, we sum the landings data for the commercial and recreational fishery together, and then divide by each category to get the corresponding percentage. This is done on a case study by case study basis.

[2] Some economists consider option values to be a part of nonuse values because the option value is not derived from actual current use. Alternatively, some other writers place option value in a use category, because the option value is associated with preserving opportunity for a future use of the resource. Both interpretations are supportable, but for this presentation we place option value in the nonuse category in Figure A9-1.

increased revenues through increases in total landings and/or increases in the catch per unit of effort (i.e., lower costs per fish caught). Increases in catch may also lead to growth in related commercial enterprises, such as commercial fish cleaning/filleting, commercial fish markets, recreational charter fishing, and fishing equipment sales.[3]

Evidence that these use benefits are highly valued by society can be seen in the market and other observable data. For example, in 1996, over 35 million recreational anglers spent nearly $38 billion on equipment and fishing trip related expenditures (US DOI, 1997), and the 1996 GDP from fishing, forestry, and agricultural services (not including farms) was about $39 billion (BEA, 1998). Americans spent an estimated 626 million days engaged in recreational fishing in 1996, an increase of 22 percent over the 1991 levels (U.S. DOI, 1997). If the average consumer surplus per angling day were only $20 — a conservative figure relative to the values derived by economic researchers over the years (e.g., Walsh et al., 1990), review 20 years of research and derive an average value of over $30 per day for warm water angling, and higher values for cold water and salt water angling) — then the national level of consumer surplus enjoyed because of 1996 levels of recreational angling would be approximately $12.6 billion per year (and probably is appreciably higher).

Clearly, these data indicate that the fishery resource is very important. These baseline values do not give us a sense of how benefits change with improvements in environmental quality, such as due to reduced I&E and increased fish stocks. However, even a change of 1.0 percent would translate into potential benefits of approximately $100 million per year or more, based on the limited metrics noted above that relates only to recreational angling consumer surplus.

Commercial fisheries. The social benefits derived from increased landings by commercial fishermen can be valued by examining the markets through which the landed fish are sold. This entails a series of steps that are detailed below. The first step of the analysis involves a fishery-based assessment of I&E-related changes in commercial landings (pounds of commercial species as sold dockside by commercial harvesters) in each case study. The changes in landings are then valued according to market data from relevant fish markets (dollars per pound) to derive an estimate of the change in gross revenues to commercial fishermen. The final steps entail converting the I&E-related changes in gross revenues into estimates of social benefits. These social benefits consist of the sum of the producers' and consumers' surpluses that are derived as the changes in commercial landings work their way through the multi-market commercial fishery sector. Each step is described below.

To estimate the impact that § 316(b) regulations may have on commercial landings, the biological assessment described in Chapter A5 provided estimates of the change in commercial catch of adult equivalent fish in a given CWIS-impacted waterbody. Yields to the commercial fishery were derived by estimating the number of fish (and species-associated pounds) of commercial species reaching harvest age, and then increasing landings in accordance with species- and location-specific fishery mortality rates (i.e., the percent of the given stock that fishery experts believe is harvested). For species that are harvested by both recreational and commercial anglers, the historical allocation of landings was used to split the yield into each sector. The change in catch was used to infer a like-sized change in landings, on a species- and site-specific basis.

This approach embodies an assumption that there is a linear relationship between changes in the fishery stock and changes in landings, with the slope based on fishery (harvest) mortality rates. The actual stock-to-harvest relationship may be not be linear for some species and/or locations (i.e., it is uncertain whether harvest is an increasing, decreasing, or constant function of stock size). However, the linear approach is likely to provide a reasonable approximation for the marginal changes in the fisheries that are being evaluated in this analysis. In addition, it is likely that the fisheries-related approach develops underestimates of the changes in stocks attributable to I&E. This is because I&E monitoring often depicts impacts to already depleted fisheries, and fishery mortality rates used to assign a small portion of the stock to landings (yields) also reflect conditions of fisheries that often are in decline. Therefore, the linear estimates are based on projections of changes in stocks that are probably underestimated. Since stock change estimates are probably understated, the linear extrapolations are likely to provide results that are comparable to a declining stock-to-harvest function.

The next step is the assign a market value to the estimated change in commercial landings. In the case studies, presented in Parts B through I of this document, all market values were obtained for each state from the National Marine and Fisheries Service (NMFS), based on data located at the NMFS website (www.st.nmfs.gov). NMFS obtained market values for each state from a census of the volume and value of finfish and shellfish landed and sold at the dock. Principal landing statistics that are collected consist of the pounds and dockside (ex-vessel) dollar value of landings identified by species, year, month,

[3] Increased revenues are often realized by commercial ventures whose businesses are stimulated by environmental improvements. These revenue increases do not necessarily reflect gains in national level "economic welfare" and, therefore, are not usually included in a benefit-cost analysis. However, these positive economic impacts may be sizable and of significance to local or regional economies — and also of national importance — in times when the economy is not operating at full capacity (i.e., when the economic impacts reflect real gains and not transfers of activity across regions or sectors).

state, county, port, water and fishing gear. Most states get their landings data from seafood dealers who submit monthly reports of the weight and value of landings by vessel (NMFS, 2001a). A ten year average (1990-1999) of the market values were used to even out inter-annual fluctuations, and where a facility's surrounding watershed boundaries were included in multiple states, an average of the states' market values were used. All values are stated in year 2000 dollars.

The final set of steps entails converting the dockside market value of changes in commercial landings into the measures of economic surplus that constitute social benefits. These surplus measures include producer surplus to the watermen who harvest the fish, as well as the rents and consumer surplus that accrue to buyers and sellers in the sequence of market transactions that apply in the commercial fishery context. To do this with primary analysis would be an extremely complex process for each fish market. However, several primary research efforts exist that can be used in a benefits transfer that enables EPA to estimate the total economic surplus (social benefits) that arise from changes in commercial landings.

An important portion of commercial fishing benefits is the producer surplus generated by the estimated marginal increase in landings, but typically the data required to compute the producer surplus are unavailable. Various researchers, however, have developed empirical estimates that can be used to infer producer surplus for watermen based on gross revenues (landings times wholesale price). The economic literature (Huppert, 1990; Rettig and McCarl, 1985) suggests that producer surplus values for commercial fishing ranges from 50 to 90 percent of the market value. That is, the wholesale landings values are a close proxy for producer surplus because the commercial fishing sector has very high fixed costs relative to its variable costs. Therefore, the marginal benefit from an increase in commercial landings can be estimated to be approximately 50 to 90 percent of the anticipated change in commercial fishing revenues. In assessments of Great Lakes fisheries, an estimate of approximately 40% has been derived as the relationship between gross revenues and the surplus of commercial fishermen (Cleland and Bishop, 1984; Bishop, personal communication, 2002; and Holt and Bishop, 2002).[4]

The 90 percent estimate of producer surplus relative to gross landings revenue implies a situation in which supply is relatively inelastic and demand is relatively unaffected by changes in supply. This may be suitable in the short run for many fisheries (and perhaps long term for some fisheries) in which watermen experience an increase in landings while: (1) there is no change in harvesting behavior or effort (e.g., due to high fixed costs relative to marginal costs), and (2) there is no appreciable change in price (e.g., where changes local landings have no appreciable impact on broader market prices).[5] For the purposes of this study, however, EPA believes producer surplus estimates in the range of 40% to 70% of landings values (rather than up to 90%) probably are a more suitable reflection of longer-term market conditions.

Producer surplus is one portion of the total economic surplus impacted by increased commercial stocks — the total benefits are comprised of the economic surplus to producers, wholesalers, processors, retailers, and consumers (Norton et al., 1983; Holt and Bishop, 2002). Primary empirical research deriving "multi-market" welfare measures for commercial fisheries have estimated that surplus accruing to commercial anglers amount to 22.2% of the total surplus accruing to watermen, retailers and consumers combined in the striped bass markets in New York and Baltimore (Norton et al., 1983); and 22.3% in the Great Lakes (Bishop, personal communication, 2002, and Holt and Bishop, 2002). This relationship is applied in the case studies to estimate total surplus from the projected changes in commercial landings. Figure A9-2 displays the composition of the total economic surplus.

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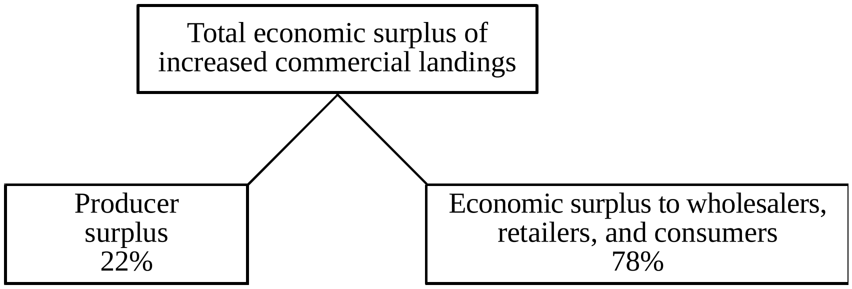
[4] Cleland and Bishop indicate nearly 30% (1981 fishery), but a more recent empirical investigation by Bishop (personal communication, January 2002, pertaining to a confidential litigation support report developed by Bishop in 2000) provides updated fishery estimates that indicate producer surplus was approximately 42% of the 1999 dockside landings value for the relevant fisheries).

[5] Alternative assumptions and scenarios are plausible, but the net impact on total economic surplus would probably not be appreciable (for example, if market prices decreased with increased catch, then commercial fishermen may enjoy less producer surplus, but this would be offset — at least in part — by gains in consumer surplus).

Figure A9-2: Components of Total Surplus



The methods described above are summarized in Table A9-1, in an example on how EPA estimated the baseline economic impact from I&E losses of striped bass at Salem Nuclear Generating Station (Salem) in New Jersey. First, per pound dockside values were obtained for striped bass in Delaware and New Jersey, and then a weighted average of the two values was obtained, weighted by the total landings in each state. Then this per pound value is multiplied by the annual I&E rates to obtain an annual market value of the losses from I&E. Then, 40 percent to 70 percent of the market value is estimated as the producer surplus. Finally, the total economic social benefit from the striped bass commercial fishery is obtained by dividing the producer surplus by 22 percent.

Table A9-1: Annual I&E Commercial Fishing Impacts on Striped Bass at Salem (baseline)

Step 1. Derive per pound market value of landed shad	
a. Derive DE $/lb	
Catch DE (lb) (total 1990-1999)	3,762,358
Value DE	$3,474,742
DE $/lb	$0.92
b. Derive NJ $/lb	
Catch NJ (lb) (total 1990-1999)	10,437,399
Value NJ	$6,396,137
NJ $/lb	$0.61
c. Derive weighted DE/NJ average $/lb	
% catch DE	36.5%
% catch NJ	63.5%
Weighted average (per lb)	$0.73
Step 2. Determine market value of I&E landings impacts	
a. Baseline I&E impact of commercial landings (lbs)	612,715
b. Market value of I&E impact (weighted ave $ * I&E lbs)	$444,973
Step 3. Develop surplus estimates	
a. Producers surplus low (mkt value * 0.4)	$177,989
b. Producers surplus high (mkt value * 0.7)	$311,481
c. Total social benefit - low (prod surplus /0.22)	$809,041
d. Total social benefit - high (prod surplus /0.22)	$1,415,823

Recreational users. The benefits of recreational use cannot be tracked in the market, since much of the recreational activity associated with fisheries occurs as nonmarket events. However, there is an extensive literature on valuing recreational fishing trips and valuing increased catch rates on fishing trips. Participants in recreational activities other than fishing may also benefit from a reduction in I&E. For example, bird watchers may find more abundance and diversity of piscivorus species if the fishery populations are enhanced. Likewise, boaters may receive added recreational value to the degree that enjoyment of their surroundings is an important part of their recreational pleasure or that fishing is a secondary reason for boating.

Primary studies of sites throughout the United States have shown that anglers value their fishing trips and that catch rates are one of the most important attributes contributing the quality of their trips. Higher catch rates may translate into two components of recreational angling benefits: (1) an increase in the value of existing recreational fishing trips, and (2) an increase in recreational angling participation. The most promising and practical approaches for quantifying and monetizing these two benefits components are random utility modeling or RUM (as a primary research method) and benefits transfer (as a secondary method applied when data and other constraints limit the feasibility of doing site-specific primary research). The RUM approach has been applied in the watershed-level case studies, and is described in greater detail in Chapter A10.

For each case study (including the watershed-level sites for which a RUM approach was also deployed), a benefits transfer approach was used as a basis for estimating recreational benefits. There is a large literature that provides willingness-to-pay values for increases in recreational catch rates. These increases in value are benefits to the anglers and reflect their "consumer surplus" which in some instances are reported on the basis of value per additional fish caught.[6] For each case study, monetary values for increased angler consumer surplus were drawn from those credible research efforts that estimated consumer surplus for locations closest in geographic area and relevant species to the I&E-impacted sites. To estimate a unit value for recreational landings, lower and upper values were established for the recreational species, based on values revealed in the suitable literature. Table A9-2 shows some of the studies that were used in the case study analyses, the case studies and aquatic species these studies were applied to, the range of dollar values used, and the economic method(s) used in the study (e.g., contingent valuation, travel cost, or random utility modeling).[7]

The incremental increase in recreational landings is estimated based on the biological modeling of how reduced I&E will change the catch of adult equivalent fish (as described in Chapter A5). Willingness-to-pay estimates for increases in catch are then applied to these changes in catch to obtain monetary estimates of total recreational value of fish lost through I&E.

In some cases it may be reasonable to assume that increases in fish abundance (attributable to reducing I&E) will lead to an increase in recreational fishing participation. The expected value of an increase in participation is directly related to the amount of degradation occurring at baseline. For example, the greatest changes are likely to occur in a location that has experienced such a severe impact to the fishery that the site is no longer an attractive location for recreational activity. Estimates of potential recreational activity post-regulation can be made based on similar sites with healthy fishery populations, on conservative estimates of the potential increase in participation (e.g., a 5 percent increase), or on recreational planning standards (densities or level of use per acre or stream mile). A participation model (as in a RUM application) provides a more robust alternative to predict changes in the net addition to user levels from the improvement at an impacted site. The economic benefit of the increase in angling days then can be estimated using values derived from the RUM analysis itself (as is done in the case studies presented in Parts B, C, and D of this document), or by drawing from the economic literature for a similar type of fishery and angling experience. Where primary research is not feasible, estimates of potential recreational activity post-regulation can sometimes be made based on similar sites with healthy fishery populations, on conservative estimates of the potential increase in participation, or on recreational planning standards (densities or level of use per acre or stream mile).[8]

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[6] In some studies, estimated consumer surplus is based on other metrics, such as dollar per user day. However, such measures can be translated into consumer surplus values per fish caught if sufficient catch data are available.

[7] Note that the recreational angling valuation studies used in this benefits analysis for § 316(b) differ from the studies recently applied by EPA in several other water quality regulations. For example, the metal products and machinery effluent guidelines rulemaking was evaluated using eight studies that were used to infer a percent change in recreational consumer surplus (relative to baseline levels) for a change in water quality and/or fish toxicity levels. For § 316(b), however, the benefits analysis is driven by estimated changes in fish abundance rather than a change in chemical concentrations. Accordingly, different literature is used in the benefits transfer.

[8] EPA has not yet attempted to factor in increased participation as part of its benefits transfer analysis of recreational fishing benefits, but such impacts are embedded in the RUM applications provided in this document.

Table A9-2: Economic Literature Applied in Case Studies for Recreation Angling Valuation.

Study	Some Case Studies Applied to:	Some Species Applied to:	Range of Values Used per Fish ($2000)		Study Type
			Low	High	
Agnello, 1989	Delaware, Brayton	Weakfish	$2.72	$2.72	Travel cost method: multi-site; regional / hedonic
Boyle et al., 1998	Ohio	Bass (largemouth, white, red, rock, smallmouth, spotted, yellow), rainbow trout	$1.58	$3.95	Contingent valuation: dichotomous choice
Charbonneau and Hay, 1978	Ohio	Catfish (channel, blue, flathead, white), crappie (black, white), perch (white, yellow), sauger, walleye, bluegill, pumpkinseed, green sunfish, longear sunfish, redear sunfish, warmouth, grass pickerel, northern pike, muskellunge, paddlefish	$1.00	$7.92	Travel cost method: single site; Contingent valuation: open ended
Hicks et al., 1999	Delaware, Pilgrim, Seabrook, Brayton	American shad, Atlantic cod, Atlantic croaker, Atlantic mackerel, black sea bass, bluefish, cunner, pollock, red hake, searobin, spot, striped bass, summer flounder, tautog, weakfish, white perch, winter flounder	$2.01	$5.29	Simple travel cost method and contingent valuation
Huppert, 1989	California	Striped bass	$9.11	$14.14	Travel cost and contingent valuation
Loomis, 1988	Ohio	Coho salmon	$12.39	$12.39	Travel cost: multi-site
McConnell and Strand, 1994	Delaware, Pilgrim, Seabrook, Brayton, Ohio	American shad, Atlantic cod, Atlantic croaker, Atlantic mackerel, black sea bass, bluefish, cunner, pollock, red hake, searobin, spot, striped bass, summer flounder, tautog, white perch, winter flounder	$0.62	$8.59	Contingent valuation and Random Utility Modeling
Milliman et al., 1992	Ohio	Perch (white, yellow), bluegill, pumpkinseed, green sunfish, longear sunfish, redear sunfish, warmouth	$0.31	$0.31	Contingent valuation: dichotomous choice
Norton et al., 1983	Delaware, Ohio	Striped bass	$11.08	$15.55	Travel cost method: multi-site; regional / hedonic
Samples and Bishop, 1985	Ohio	Coho salmon	$16.01	$16.01	Travel cost method: multi-site; regional / hedonic
Sorg et al., 1985	Ohio	Catfish (channel, blue, flathead, white), crappie (black, white), walleye, sauger, grass pickerel, northern pike, muskellunge, paddlefish	$5.02	$5.02	Travel cost method: multi-site; regional / hedonic; Contingent valuation: iterative bidding

Subsistence anglers. Subsistence use of fishery resources can be an important issue in areas where socioeconomic conditions (e.g., the number of low income households) or the mix of ethnic backgrounds make such angling economically or culturally important to a component of the community. In cases of Native American use of impacted fisheries, the value of an improvement can sometimes be inferred from settlements in legal cases (e.g., compensation agreements between impacted tribes and various government or other institutions in cases of resource acquisitions or resource use restrictions). For more general populations, the value of improved subsistence fisheries may be estimated from the costs saved in acquiring alternative food sources (assuming the meals are replaced rather than foregone). This may underestimate the value of a subsistence-fishery meal to the extent that the store-bought foods may be less preferred by some individuals (for reasons of cultural background or simply as a matter of taste) than consuming a fresh-caught fish. Subsistence fishery benefits are not included in the case studies to date, due to a lack of data available within the time constraints of the general analysis. However, impacts on subsistence anglers may constitute an important environmental justice consideration.

A9-4 INDIRECT USE BENEFITS

Indirect use benefits refer to welfare improvements that arise for those individuals whose activities are enhanced as an indirect consequence of fishery or habitat improvements generated by the proposed existing facility standards for CWIS. For example, the rule's positive impacts on local fisheries may generate an improvement in the population levels and/or diversity of fish-eating bird species. In turn, avid bird watchers might obtain greater enjoyment from their outings, as they are more likely to see a wider mix or greater numbers of birds. The increased welfare of the bird watchers is thus a legitimate but indirect consequence of the proposed rule's initial impact on fish.

Another example of potential indirect benefits concerns forage species. A rule-induced improvement in the population of a forage fish species may not be of any direct consequence to recreational or commercial anglers. However, the increased presence of forage fish will have an indirect affect on commercial and recreational fishing values if it increases food supplies for commercial and recreational species. Thus, direct improvements in forage species populations can result in a greater number (and/or greater individual size) of those fish that are targeted by recreational or commercial anglers. In such an instance, the increment in recreational and commercial fishery benefits would be an indirect consequence of the proposed rule's initial impacts on lower trophic levels of the aquatic food web.

For the case studies, two general approaches were used to estimate the indirect value of forage fish. The first approach used two distinct estimates of trophic transfer efficiency to relate foregone forage production to foregone fisheries yield that would result from two kinds of food web pathways. The two estimates, referred to as secondary and tertiary forgone yield in this document, reflect (a) that portion of total forage production that has a high trophic transfer efficiency because it is directly consumed by harvested species and (b) the remaining portion of total forage production that has a low trophic transfer efficiency because it is not consumed directly by harvested species, but instead reaches harvested species indirectly after passage through other parts of the food web. The dollar value of foregone commercial and recreational production was estimated using the same monetary values as for the direct use benefits estimates.[9] The indirectly consumed production enhancement from forage species that is not embodied in the landed recreational and commercial fish was examined in a similar manner, but values were adjusted downwards to reflect a much lower trophic efficiency transfer rate. This approach is described in greater detail in Chapter A5. A serious limitation with this approach is that I&E data collected for CWISs often overlook impacts on forage species (focusing instead on recreational and commercial species). Therefore, the results developed using this approach generally reflect considerable underestimates of forage species values, because forage species impacts data generally are lacking in CWIS biological assessments.

The second approach considers the costs associated with direct replacement of individual fish with hatchery-reared individuals. Replacement costs typically can be used as a lower bound estimate of value because costs generally are a lower-bound proxy for values, and because in this application the approach does not consider how reduction in forage stocks may affect other species.[10] Estimates of replacement costs used in the case studies are based on the cost to produce the site-specific set of relevant forage species of North American fish for stocking, as presented by the American Fisheries Society (AFS, 1993). These costs reflect the expense of rearing a fish in a hatchery to the size of release, but do not include other costs associated with the transport or release of the fish to I&E-impacted waters. The AFS (1993) estimates these costs at approximately $1.13 per mile, but does not indicate how many fish (or how many pounds of fish) are transported for this price. Lacking relevant data, EPA does not include the transportation costs in this valuation approach. For this reason, coupled with the fact that forage species I&E impacts tend to be under-reported or omitted in CWIS field data, the replacement cost approach is likely to produce an under-estimate of the value of the forage species. In addition, it is not known at this time if there is increased mortality of stocked fish, or whether some I&E impacted species can be successfully raised in hatcheries, or if there are long term problems due to decreasing genetic variety by using hatchery-reared fish. Each of these factors would compound the degree to which hatchery costs might underestimate values.

[9] Note that while this approach is based on the value contributed by forage fish to landings of commercial and recreational species, the estimates pertain to the forage species that are impacted by I&E and are shown as an indirect use benefit (in other words, these benefit estimates are separate from and are not included in the direct use benefit estimates described above for commercial and recreational fisheries).

[10] Using replacement costs as a proxy for the value of the forage fish impacts might also overstate benefits if society's willingness to pay is less than the cost of replacement. However, there is no empirical evidence that supports this possibility, and limited evidence using the Habitat Restoration Costing (HRC) approach (Chapter A11) suggests that WTP exceeds such costs.

A9-5 NONUSE BENEFITS

Nonuse (passive use) benefits arise when individuals value improved environmental quality apart from any past, present, or anticipated future use of the resource in question. Such passive use values have been categorized in several ways in the economic literature, typically embracing the concepts of existence (stewardship) and bequest (intergenerational equity) motives. Passive use values also may include the concept that some ecological services are valuable apart from any human uses or motives. Examples of these ecological services may include improved reproductive success for aquatic and terrestrial wildlife, increased diversity of aquatic and terrestrial species, and improved conditions for recovery of T&E species.

Passive use values can only be estimated in primary research through the use of stated preference techniques such as the contingent valuation method (CVM) surveys and related stated preference techniques (e.g., conjoint analysis using surveys). In the case of the § 316(b) proposed existing facilities rule, no primary research was feasible within the budgeting, scheduling, and the other constraints faced by the Agency. Accordingly, estimates were developed by EPA based on benefits transfer, with appropriate care and caveats clearly recognized.

One long-standing benefits transfer approach for estimating nonuse values is to apply a ratio between certain use-related benefits estimates and the passive use values anticipated for the same site and resource change. Freeman (1977) applied a rule of thumb in which he inferred that national-level passive use benefits of water quality improvements were 50 percent of the estimated recreational fishing benefits. This was based on his review of the literature in those instances where nonuse and use values had been estimated for the same resource and policy change. Fisher and Raucher (1984) undertook a more in-depth and expansive review of the literature (included those studies reviewed by Freeman) and found a comparable relationship between recreational angling benefits and nonuse values. They concluded that since nonuse values were likely to be positive, applying the 50 percent "rule of thumb" was preferred over omitting nonuse values from a benefits analysis entirely.

The 50 percent rule has since been applied frequently in EPA water quality benefits analyses (e.g., effluent guidelines RIAs for the benefits analysis of rulemakings for the pulp and paper sectors and metal products and machinery, and the RIA for the Great Lakes Water Quality Guidance). At times the rule has been applied to all recreational benefits (not just angling),[11] and there are studies in the literature that imply nonuse values may not only be half of recreational fishing benefits, but might be as large as or greater than recreational values (e.g., Sutherland and Wash, 1985; Sanders et al., 1990). Thus, using the 50% rule might very well lead to an understatement of nonuse values.

The overall reliability and credibility of applying the 50 percent rule approach is, as for any benefits transfer approach, dependent on the credibility of the underlying study and the comparability in resources and changes in conditions between the research survey and the § 316(b) rule's impacts at selected sites. The credibility of the nonuse value estimate also is contingent on the reliability of the recreational angling estimates to which the 50 percent rule is applied.

Using the 50 percent rule poses several concerns and includes several limitations. On the one hand, there is long-standing precedence in using this easy to apply rule of thumb and, as noted in earlier literature reviews, using this approach is probably better than omitting nonuse values entirely. Still, EPA recognizes that legitimate concerns arise because of (1) the dated nature of the literature reviews upon which the approach is founded (several more recent studies are now available and need to be reviewed and incorporated in how the body of literature is interpreted); (2) the key differences in the studies underlying the initial reviews (as noted in Fisher and Raucher, 1984, the studies vary considerably in what they are attempting to measure, even though they consistently derive ratios in their value estimates approximating 50 percent); and (3) the problems inherent in how the results of individual studies (or the collective body of research) should be applied in order to be as consistent as possible with the underlying literature (for example, applying the study by Mitchell and Carson, 1986, implies that the 50 percent rule may reflect the nonuse component of the total value held by users, but would overlook the nonuse values held by the large number of individuals or households that are NOT users of the impacted water resources – resulting in a significant omission from the total nonuse value estimates).

Therefore, despite the longstanding and widespread application of the 50 percent rule, EPA intends to revisit the body of research on this topic and re-evaluate how to apply benefits transfer in developing estimates of nonuse value benefits in the future. In the interim, the Agency will continue to apply the 50 percent rule for this proposed rule, acknowledging the limitations of the approach.

[11] E.g., the EEBA for the Metal Products and Machinery rulemaking, Chapter 15.

A second potential approach to deriving estimates for § 316(b) passive use values is to use benefits transfer to apply an annual willingness-to-pay estimate per nonuser household (e.g., Mitchell and Carson, 1986; Carson and Mitchell, 1993) to all the households with passive use motives for the impacted waterbody.[12] The challenges in this approach include defining the appropriate "market" for the impacted site (e.g., what are the boundaries for defining how many households apply), as well as matching the primary research scenario (e.g., "boatable to fishable") to the predicted improvements at the § 316(b)-impacted site.

As a third potential approach, for some specific impacted fish species, nonuse (or total) valuation may be deduced using restoration-based costs as a proxy for the value of the change in stocks. For example, for T&E species, the costs of restoration programs and various resource use restrictions indicate the revealed preference value of preserving the species. Where a measure of the approximate cost per preserved or restored individual fish can be deduced, and the number of individuals spared via BTA can be estimated, this is a viable approach. This approach is examined in the § 316(b) case study of the San Francisco Bay/Delta Estuary (Part E of this document). Improvements have been made to fish habitats by increasing stream flows, installing screening devices and fish passages, removing dams, and controlling temperatures. These changes in operations and technologies all entail significant costs, which society has shown to be willing to pay for the protection and restoration of healthy fish populations, particularly the T&E species of the Sacramento and San Joaquin Rivers. These investments provide a means to evaluate the loss imposed on society when a portion of these same fisheries are adversely impacted by I&E. Because the species involved in this restoration costing approach have no use value (due to their status as threatened or endangered), the approach yields an estimate of nonuse values.

A9-6 Summary of Benefits Categories

Table A9-3 displays the types of benefits categories expected to be affected by the § 316(b) rule. The table also reveals the various data needs, data sources, and estimation approaches associated with each category. Economic benefits can be broadly defined according to direct use and indirect use, and are further categorized according to whether or not they are traded in the market. As indicated in Table A9-3, "direct use" benefits include both "marketed" and "nonmarketed" goods, whereas "nonuse" and "indirect use" benefits include only "nonmarketed" goods.

[12] Note that Mitchell and Carson estimate "total value," including use and nonuse components. However, one can interpret the total value estimates for nonusers as their nonuse value (i.e., there is no difference between their total and nonuse value). One could also apply the Mitchell and Carson total use values to resource users to obtain both use and nonuse values (combined) for those households.

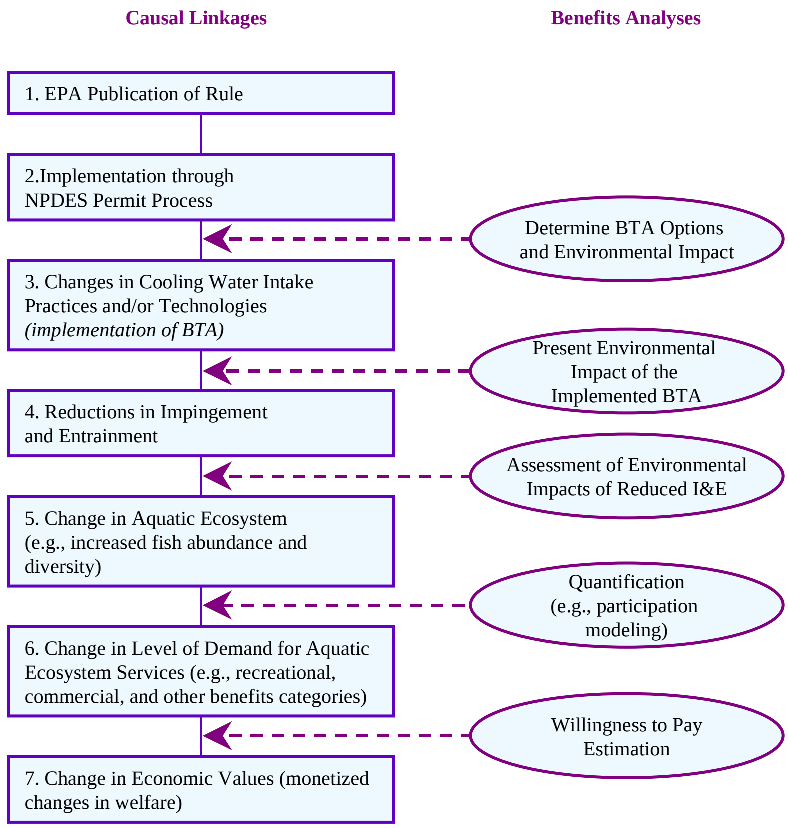
Table A9-3: Summary of Benefit Categories, Data Needs, Potential Data Sources, and Approaches.

Benefits Category	Basic Data Needs	Potential Data Sources/Approaches
Direct Use, Marketed Goods		
Increased commercial landings	▸ Estimated change in landings of specific species ▸ Estimated change in total economic impact	▸ Based on facility specific I&E data and ecological modeling ▸ Based on available literature
Direct Use, Nonmarket Goods		
Improved value of a recreational fishing experience	▸ Estimated number of affected anglers ▸ Value of an improvement in catch rate	▸ Site-specific studies, national or statewide surveys ▸ Based on available literature
Increase in recreational fishing participation	▸ Estimated number of affected anglers or estimate of potential anglers ▸ Value of an angling day	▸ Use of RUM analysis, where feasible
Increase in value of near-water recreational experience	▸ Estimated number of affected near-water recreationists ▸ Value of a near-water recreation experience	▸ Use of RUM analysis, where feasible
Increase in near-water recreational participation	▸ Estimated number of affected near-water recreationists ▸ Value of a near-water recreation experience	▸ Use of RUM analysis, where feasible
Nonuse and Indirect Use, Nonmarketed		
Increase in indirect values	▸ Estimated I&E impacts on forage species (as data permit)	▸ Based on facility specific I&E data (to degree available) and ecological modeling ▸ Site-specific studies, national or statewide surveys ▸ Application of hatchery replacement costs or biomass converted to recreational or commercial species
Increase in nonuse use values	▸ Primary research using stated preference approach (not feasible within EPA constraints) ▸ Applicable studies upon which to conduct benefits transfer	▸ Site-specific studies or national stated preference surveys ▸ Benefits transfer (e.g., application of 50 percent rule of thumb) ▸ Restoration-based costs as proxy for valuation of common and/or endangered species

A9-7 Causality: Linking the § 316(b) Rule to Beneficial Outcomes

Understanding the anticipated economic benefits arising from changes in I&E requires understanding a series of physical and socioeconomic relationships linking the installation of Best Technology Available (BTA) to changes in human behavior and values. As shown in Figure A9-3, these relationships span a broad spectrum, including institutional relationships to define BTA (from policy making to field implementation), the technical performance of BTA, the population dynamics of the aquatic ecosystems affected, and the human responses and values associated with these changes.

Figure A9-3: Causal Linkages in the Benefits Analysis



The first two steps in Figure A9-3 reflect the institutional aspects of implementing the § 316(b) rule. In step 3, the anticipated applications of BTA (or a range of BTA options) must be determined for the regulated entities. This technology forms the basis for estimating the cost of compliance, and provides the basis for the initial physical impact of the rule (step 4). Hence, the analysis must predict how implementation of BTAs (as predicted in step 3) translates into changes in I&E at the regulated CWIS (step 4). These changes in I&E then serve as input for the ecosystem modeling (step 5).

In moving from step 4 to step 5, the selected ecosystem model (or models) are used to assess the change in the aquatic ecosystem from the pre-regulatory baseline (e.g., losses of aquatic organisms before BTA) to the post-regulatory conditions (e.g., losses after BTA implementation). The potential output from these steps includes estimates of reductions in I&E rates, and changes in the abundance and diversity of aquatic organisms of commercial, recreational, ecological, or cultural value, including T&E species.

In step 6, the analysis involves estimating how the changes in the aquatic ecosystem (estimated in step 5) translate into changes in level of demand for goods and services. For example, the analysis needs to establish links between improved fishery abundance, potential increases in catch rates, and enhanced participation. Then, in step 7, as an example, the value of the increased enjoyment realized by recreational anglers is estimated. These last two steps are the focal points of the economic benefits portion of the analysis.

A9-8 CONCLUSIONS

The general methods described here are applied to the case studies which are provided in Parts B and C of this document. Variations may occur to these general methodologies to better reflect site-specific circumstances or data availability.